USGS remote sensing for Everglades science and restoration

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Case studies illustrate how Everglades process studies both require and challenge remote sensing science

- Everglades land cover is *highly dynamic*.
- Important variations in Everglades land surface and cover are *very subtle*.
- South Florida issues *demand* appropriate *scientific care*.

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Land Cover Dynamics/Environmental Processes Project

- Create diverse, well-calibrated, multi-temporal, and multi-resolution databases.
- Search for image information content, evaluate data accuracy, and address issues of scale.
- Develop and apply field, remote sensing, and landscape ecology methods to meet resource management and process study needs.

Case I: Field study of periphyton composition

Periphyton (“about plants”)

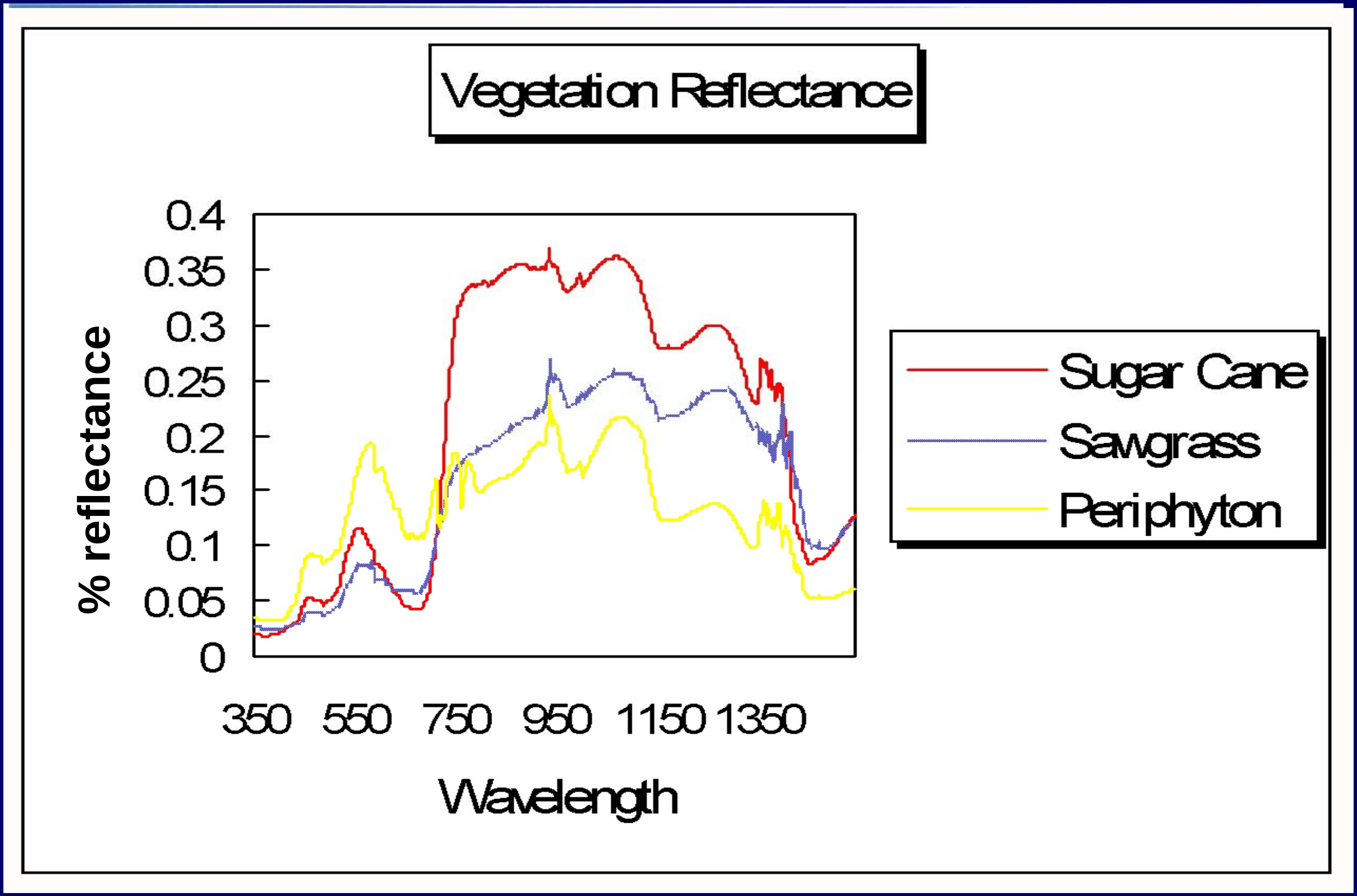
Important throughout SFL

-Base of food web

-Indicative of water quality

-Affects mercury bioavailability

-Dynamics confound remote sensing

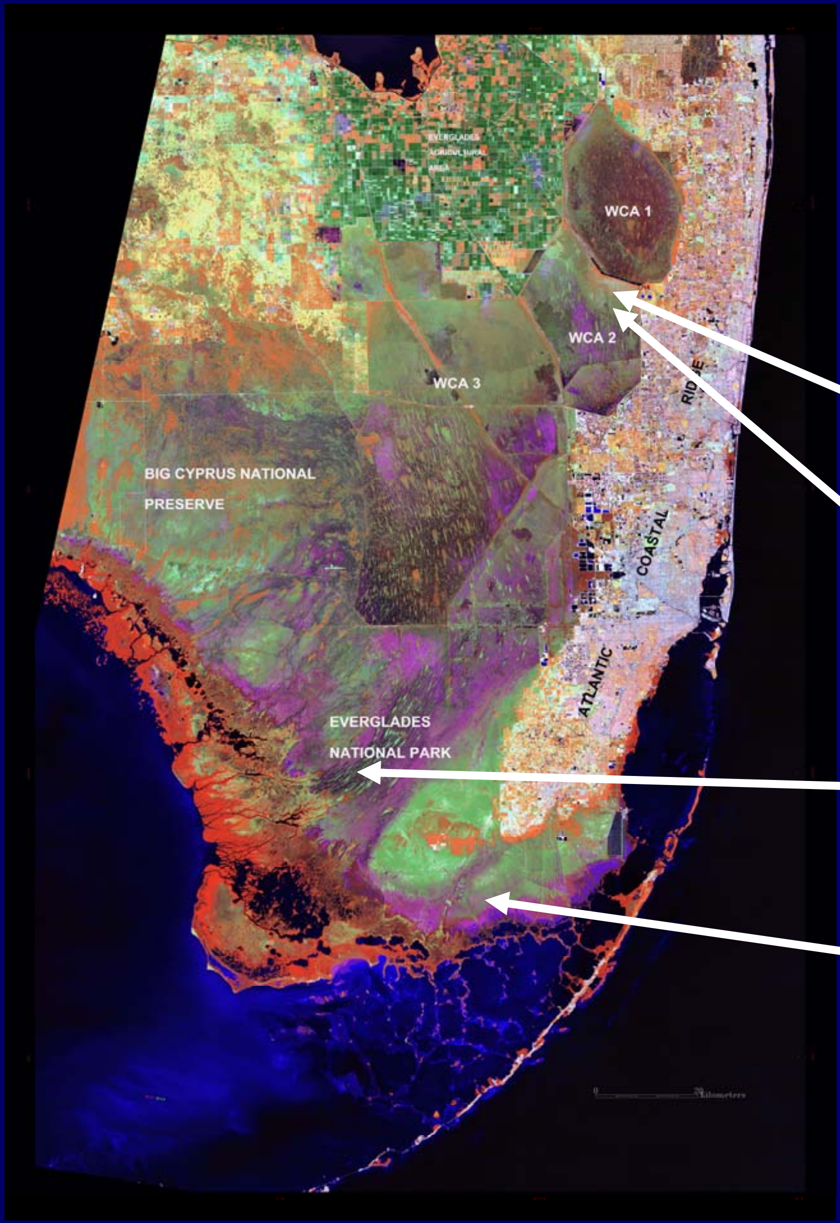


Spectra have been collected at points across the greater Everglades using a "one man band" protocol for handheld spectroradiometry.

Component	Indicator	Wavelength
Green algae	**Chl *b***	***660nm***
Cyanobacteria	**Phycocyanin** **Bchl *a***	***625nm*** ***880nm***
Brown algae/Diatoms	**fucoxanthin**	**475nm**

HPLC and literature review identified periphyton components and material indicators - translated to possible diagnostic wavelengths.

Subset of Periphyton spectra sites

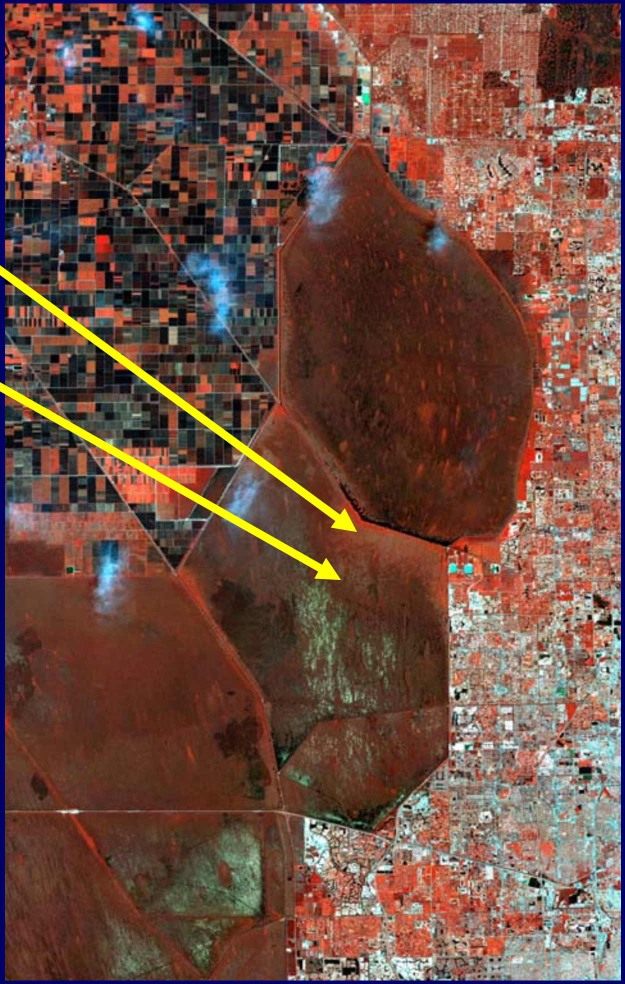


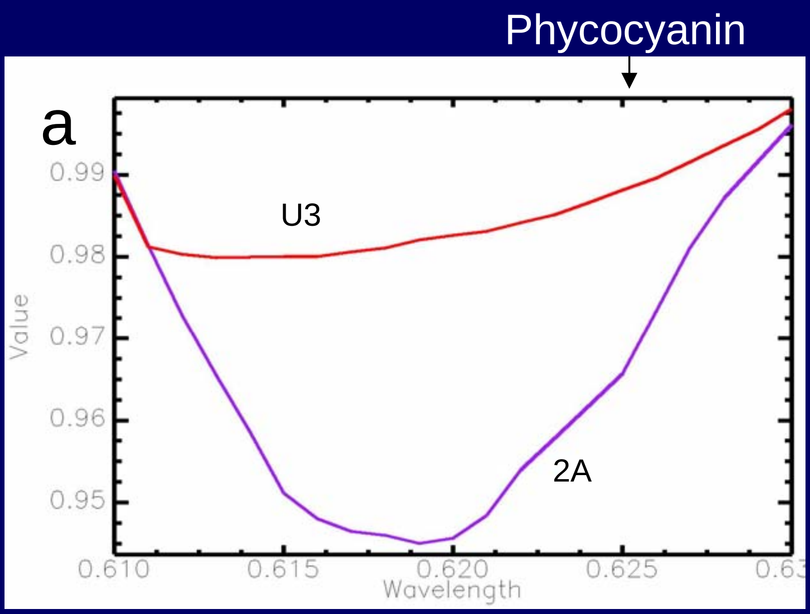
2A

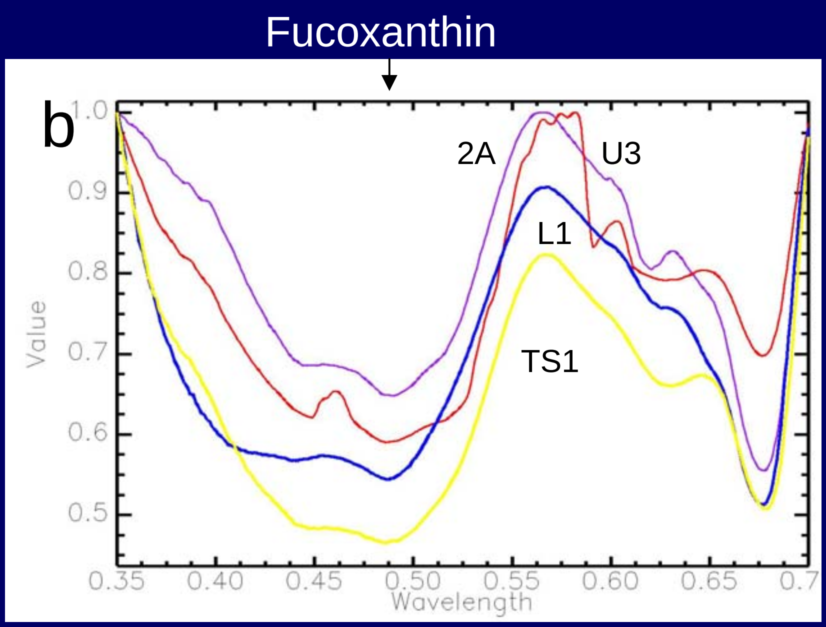
U3

L1

TS







Applied continuum-removal for indicator band-depth analysis.

-Site 2A spectra exhibit higher cyanobacteria content (a).

- Components of brown algae/diatoms increase in samples further south in the system (b).

Periphyton study implications

- Hand-held spectroscopy provides a flexible test bed for exploratory remote sensing research.
- Hyperspectral data analysis shows promise for mapping periphyton spatial distribution and monitoring periphyton dynamics.
- Quantitative documentation of periphyton content coincident with hyperspectral image collection is necessary before quantitative analyses are possible.

Collaborator(s) wanted…

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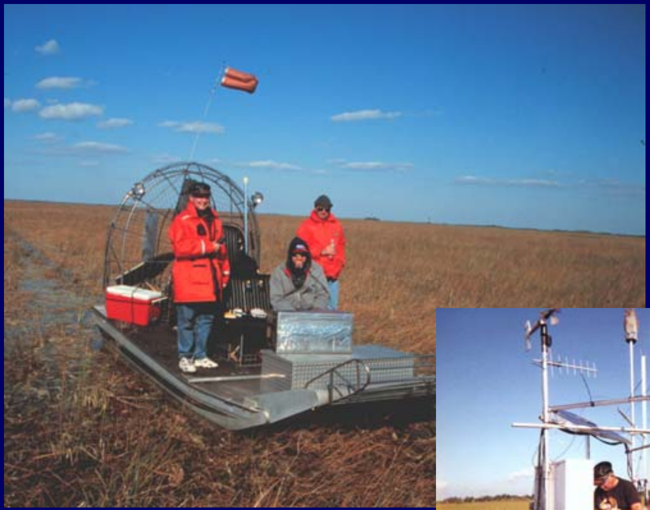
Case II: incorporating vegetation processes in hydrodynamic models

Goal: "Get the water right".



Numerous collaborators:

Ray Schaffranek (mathematician)

Ed German (hydrologist)

Nancy Rybicki (botanist)

Harry Jentor (hydrologist)

Tom Smith (ecologist)

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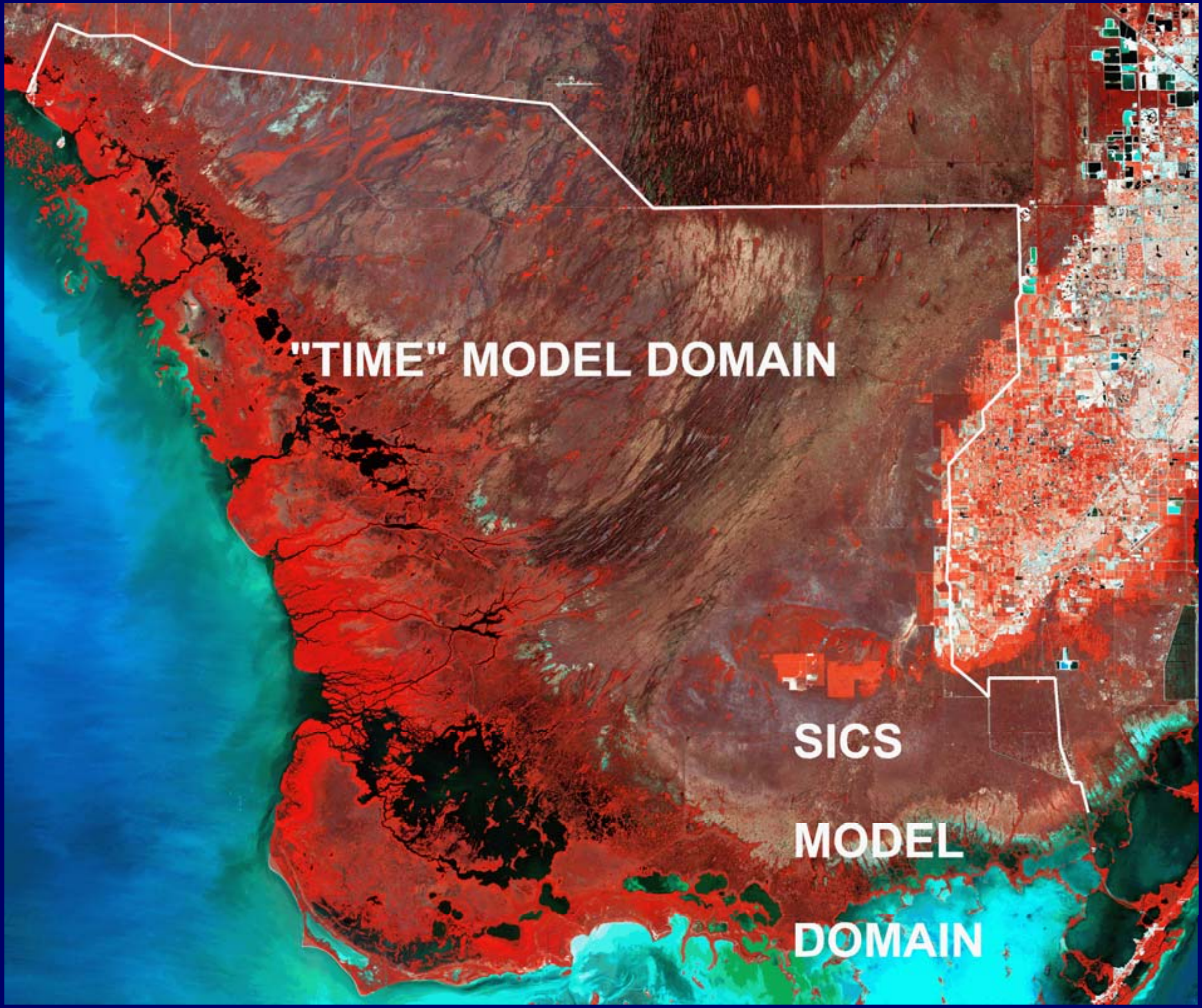
Hydrodynamic model extents/grain



Model extents selected for known boundary conditions.

Model resolution selected for practical, *not physical process* considerations.

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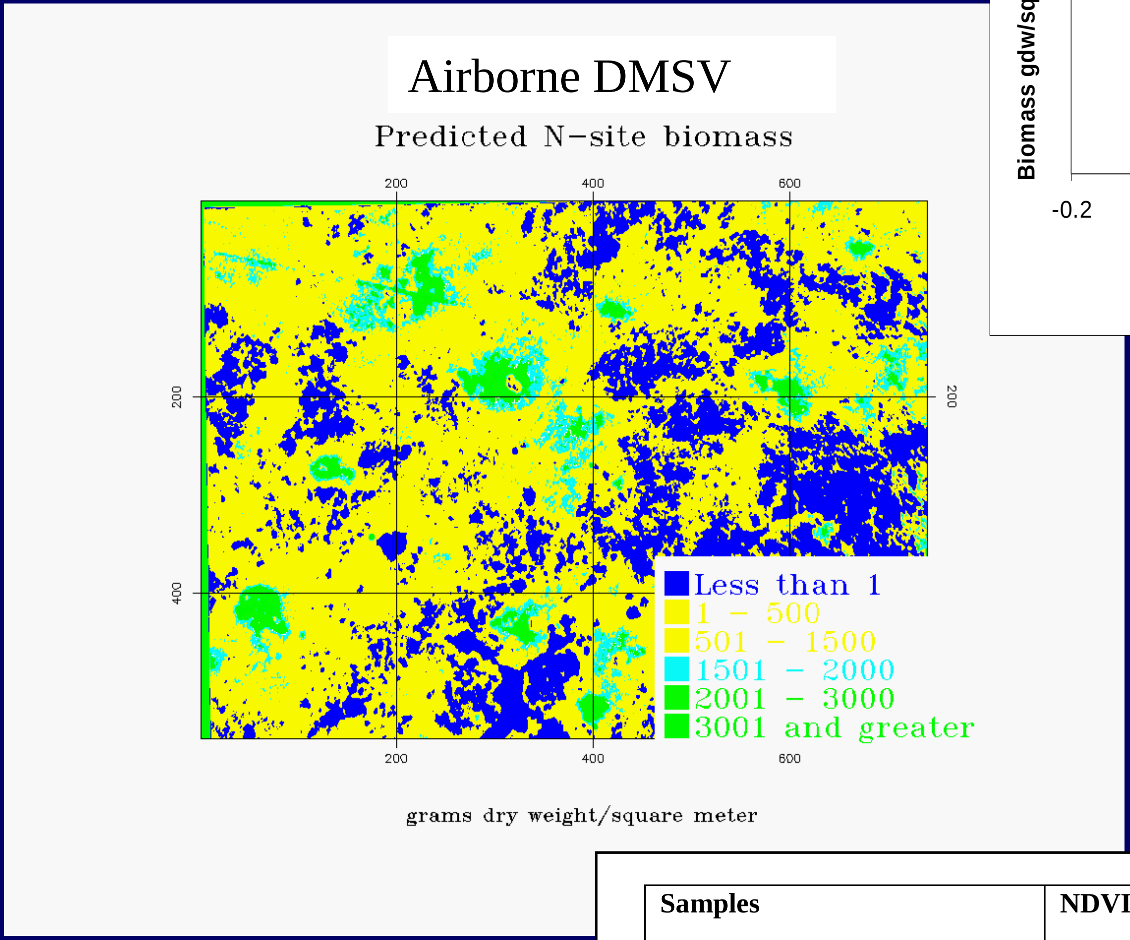
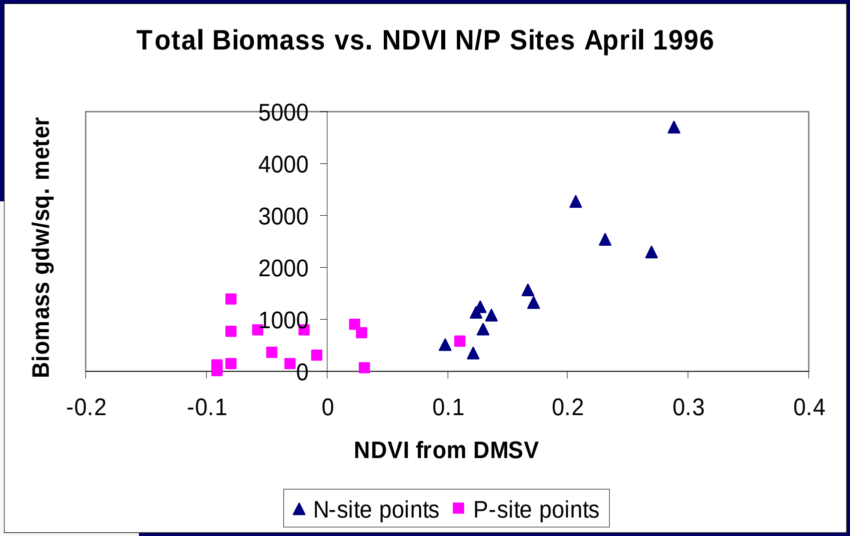
Collaborators began by looking at species/flow relationships

- Field and flume measurements of vegetation characteristics and flow resistance.

I began with scaling…

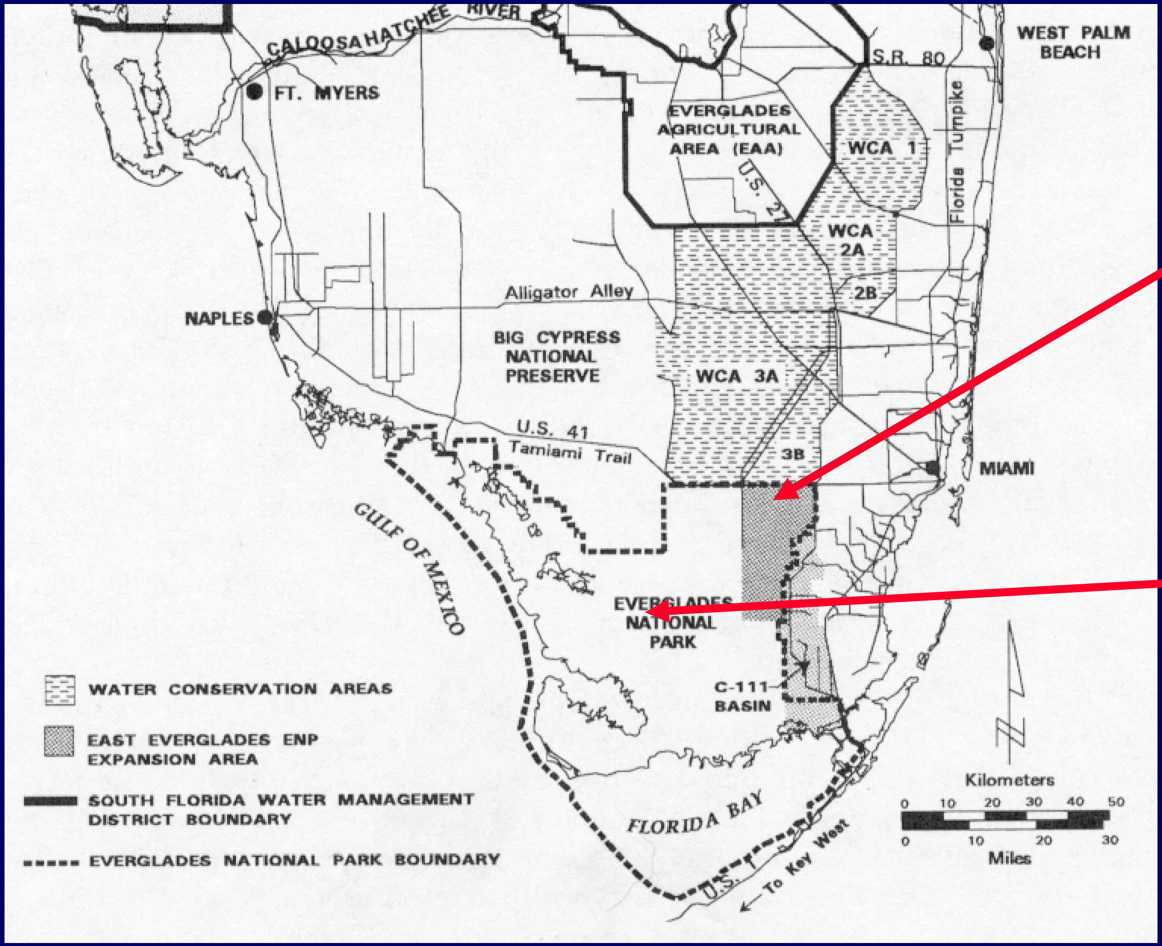




Samples	NDVI *vs.* Total Biomass	NDVI *vs.* Live Biomass
Just NESRS3 (n=12)	r^2 = .79 p= 0.0001	r^2 = .68 p= 0.0009
Just P33 (n = 14)	r^2 = .13 p= 0.2001	r^2 = .27 p= 0.0528
NESRS3 & P33 (n=26)	r^2 = .55 p= 0.0000	r^2 = .63 p= 0.0000

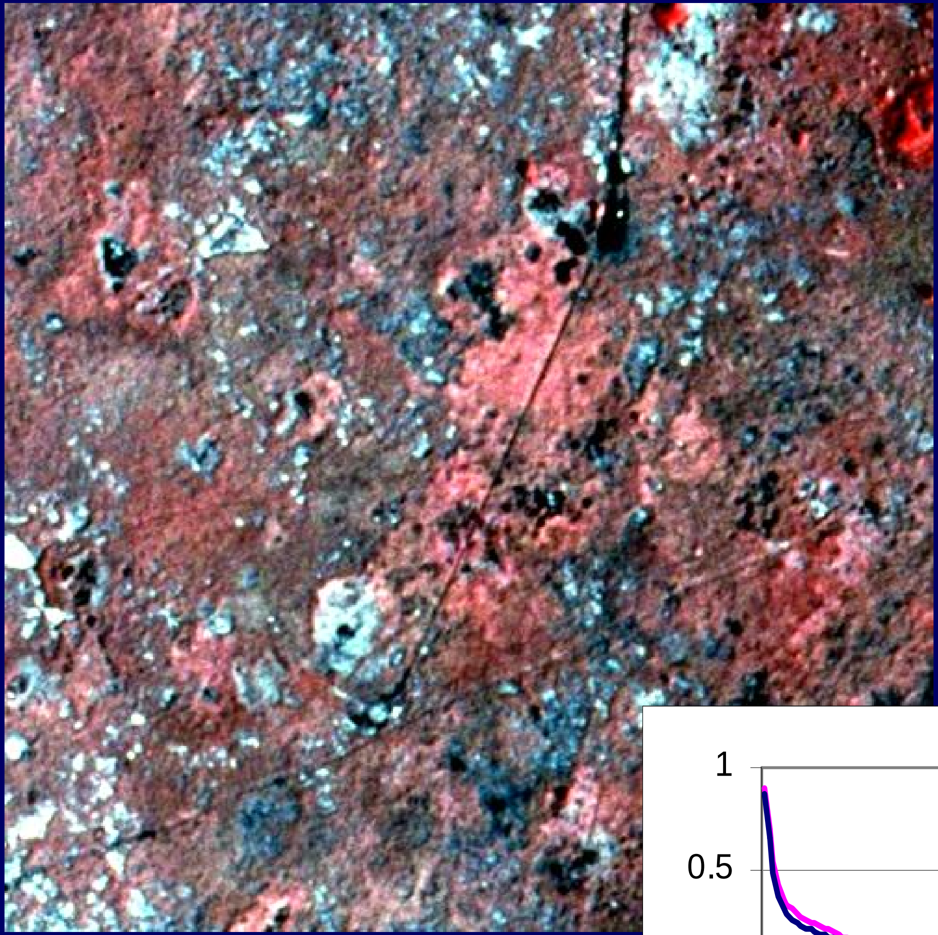
Use vegetation indices to examine spatial variation of vegetation structure/density

(Just) 2 contrasting examples in the TIME model domain

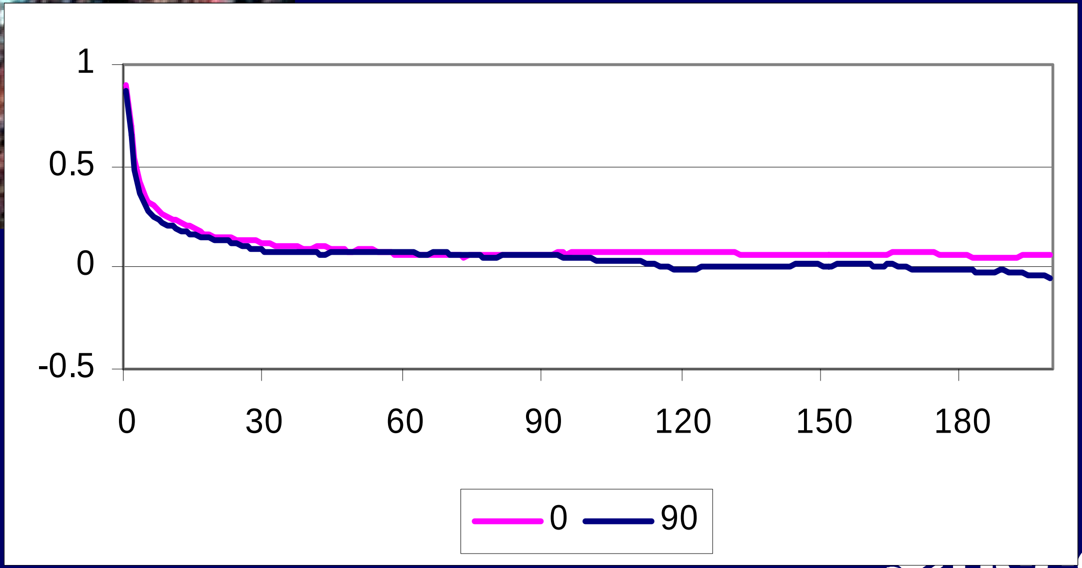


NESRS3

Panther Mound



"Downstream" of a major barrier to flow & high nutrient sources. Isotropic and very short scale lengths.



NESRS3

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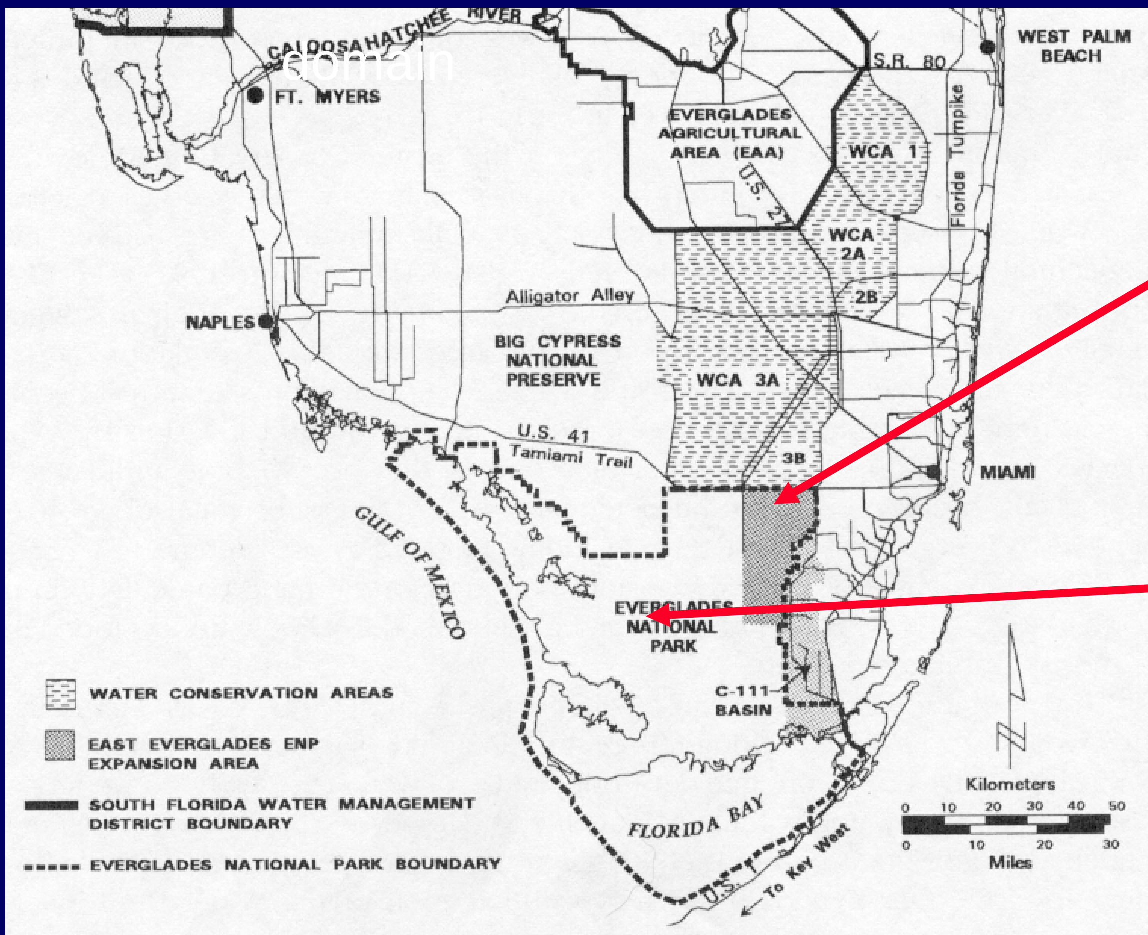
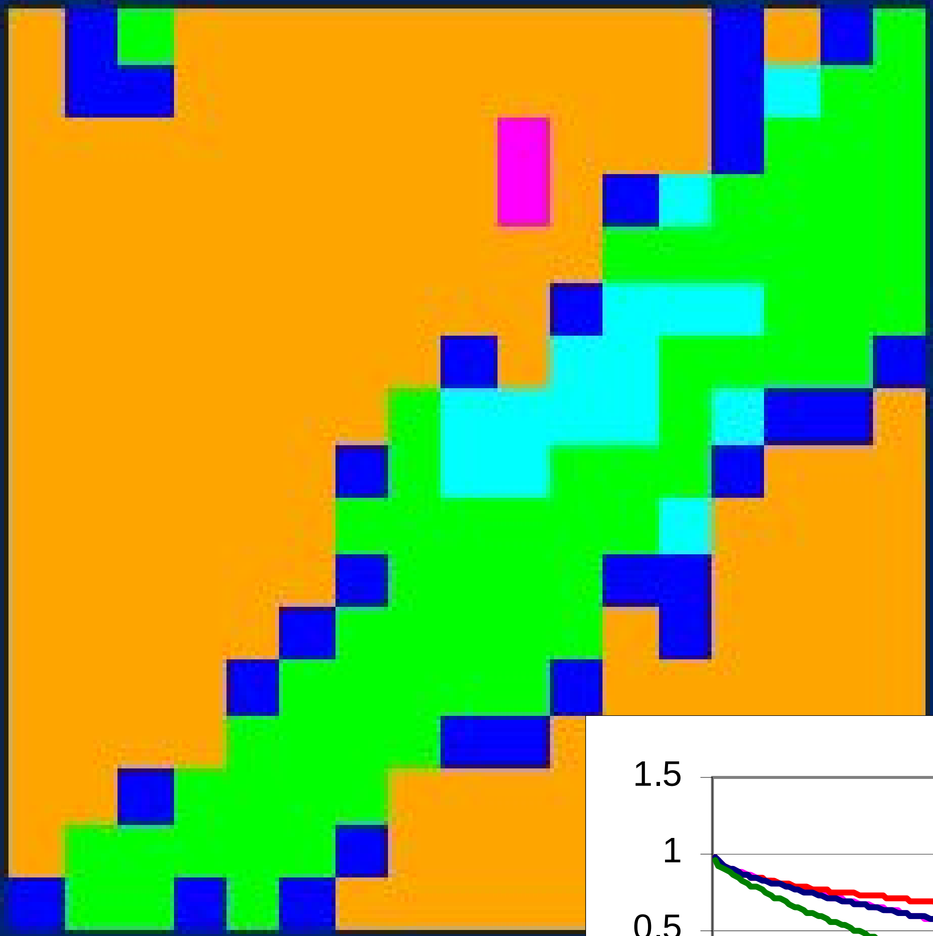
A TIME tree-island example

(Just) 2 contrasting examples in the TIME model

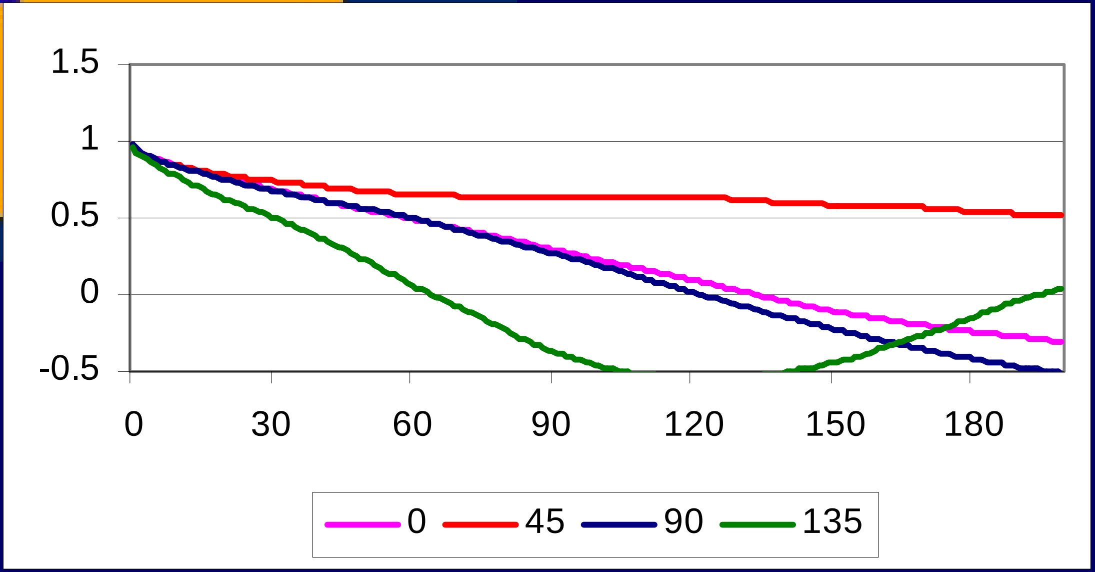


NESRS3

Panther Mound

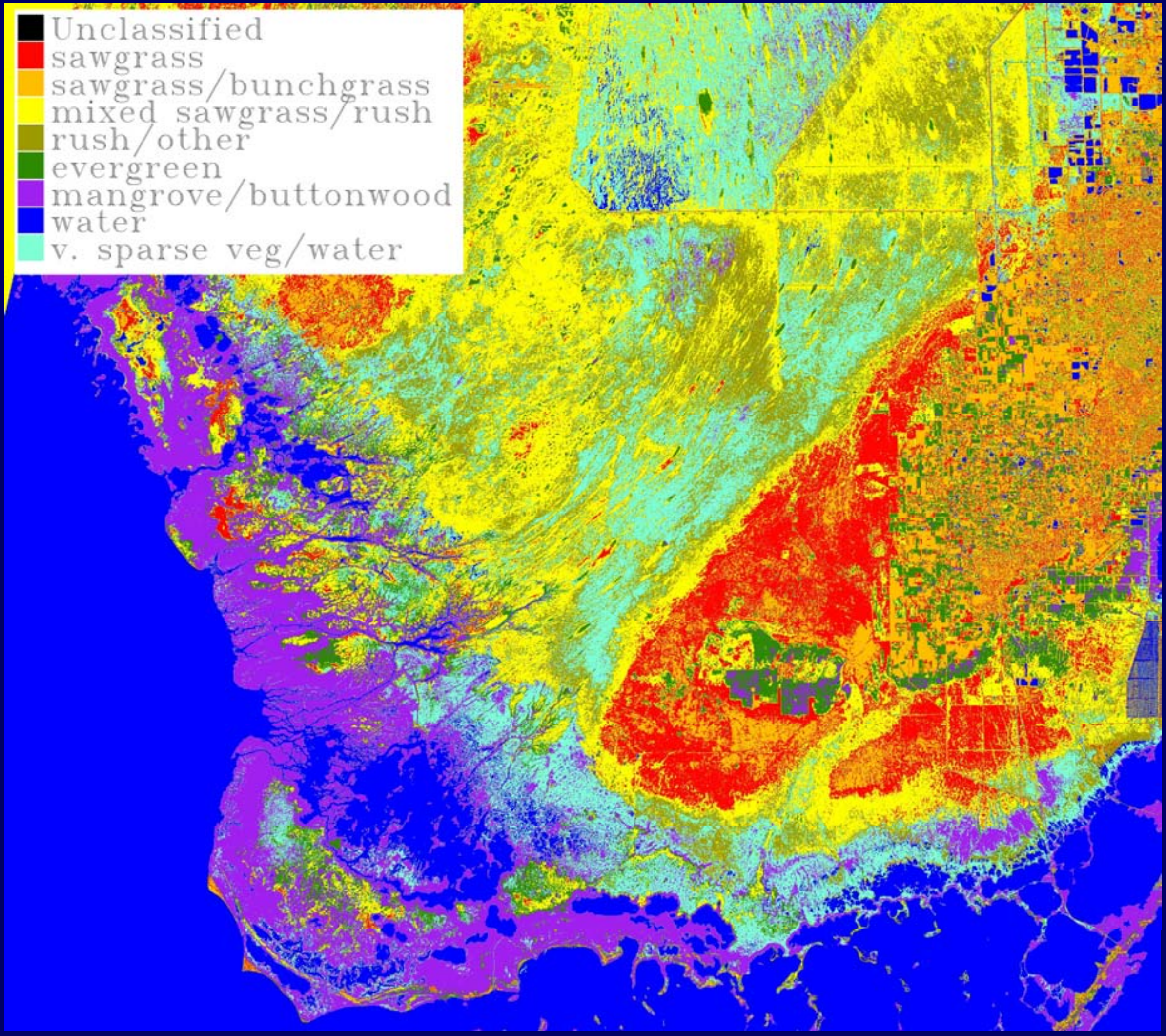


Slough area with anisotropic spatial autocorrelation. *Pattern matters!* and frictional resistances require adjustment.



Panther Mound

We mapped functional vegetation groups



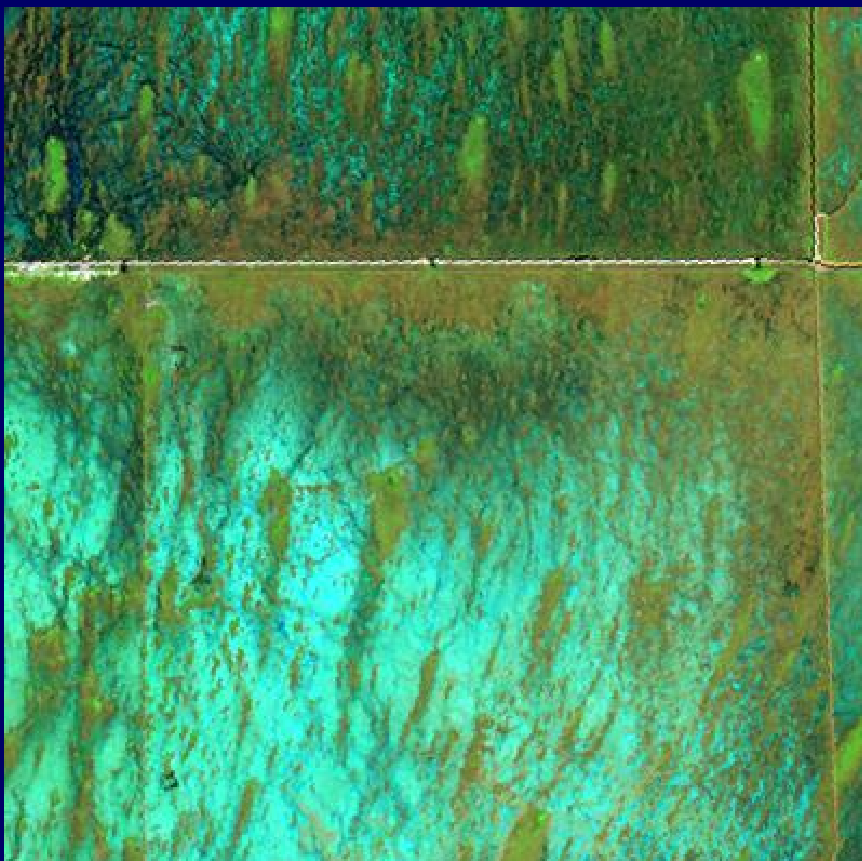
"Success" in SICS region supported a 7-class vegetation type/density map tied to field measured frictional resistances.

Enough time for TIME?

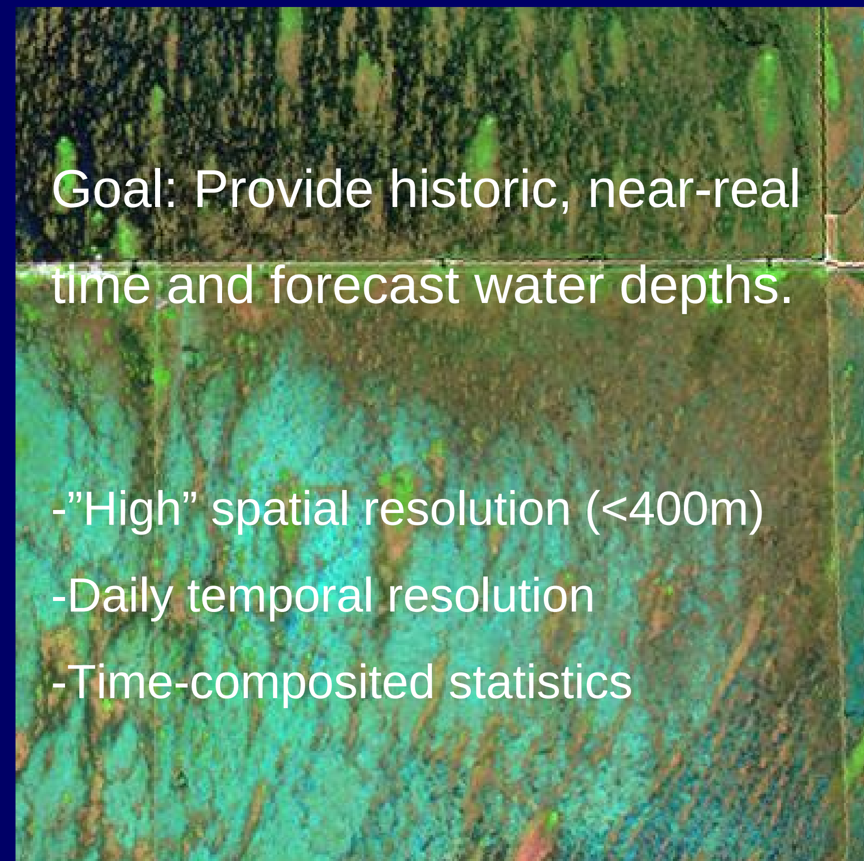
Vegetation/Hydrology study implications

- Sub-cell heterogeneity is now being addressed in Everglades hydrodynamic model development.
- Realistic parameters bolster confidence in forecasts used for flow regulation and restoration planning.
- Opportunities (if not demands) abound for exploitation of landscape ecology concepts.

Case III: Everglades Depth Estimation Network (EDEN) DEM development



NESR3 03/21/1996



Goal: Provide historic, near-real time and forecast water depths.

-"High" spatial resolution (<400m)

-Daily temporal resolution

-Time-composited statistics

NESR3 02/26/1999

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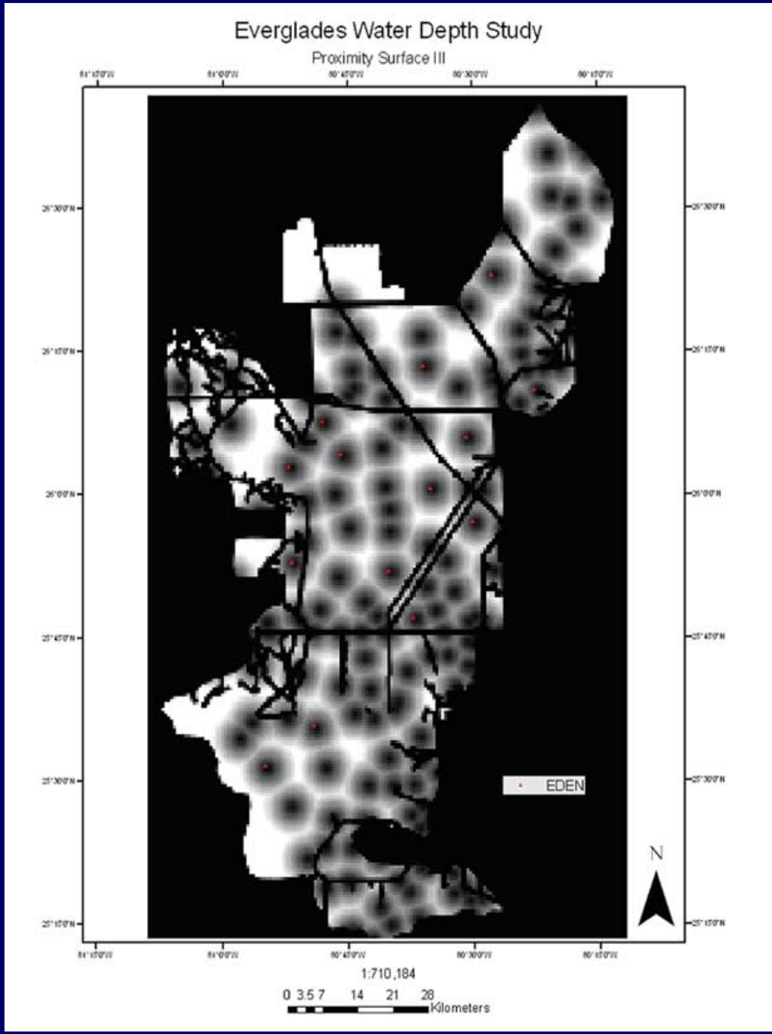
EDEN Network and Collaborators



Current gage network

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Pamela Telus (Engineer)

Roy Sonenshein (Hydrologist)

Heather Henkle (Information Spec.)

Aaron Higer (Hydrolgist, Ret.)

University of Florida

Leonard Pearlstine (Professor)

Monica Palaseanu (Geographer)

Ikuko Fujisaki (Forester)

US F&WS

Wiley Kitchens (Biologist)

Dale Gawlik (Ecologist)

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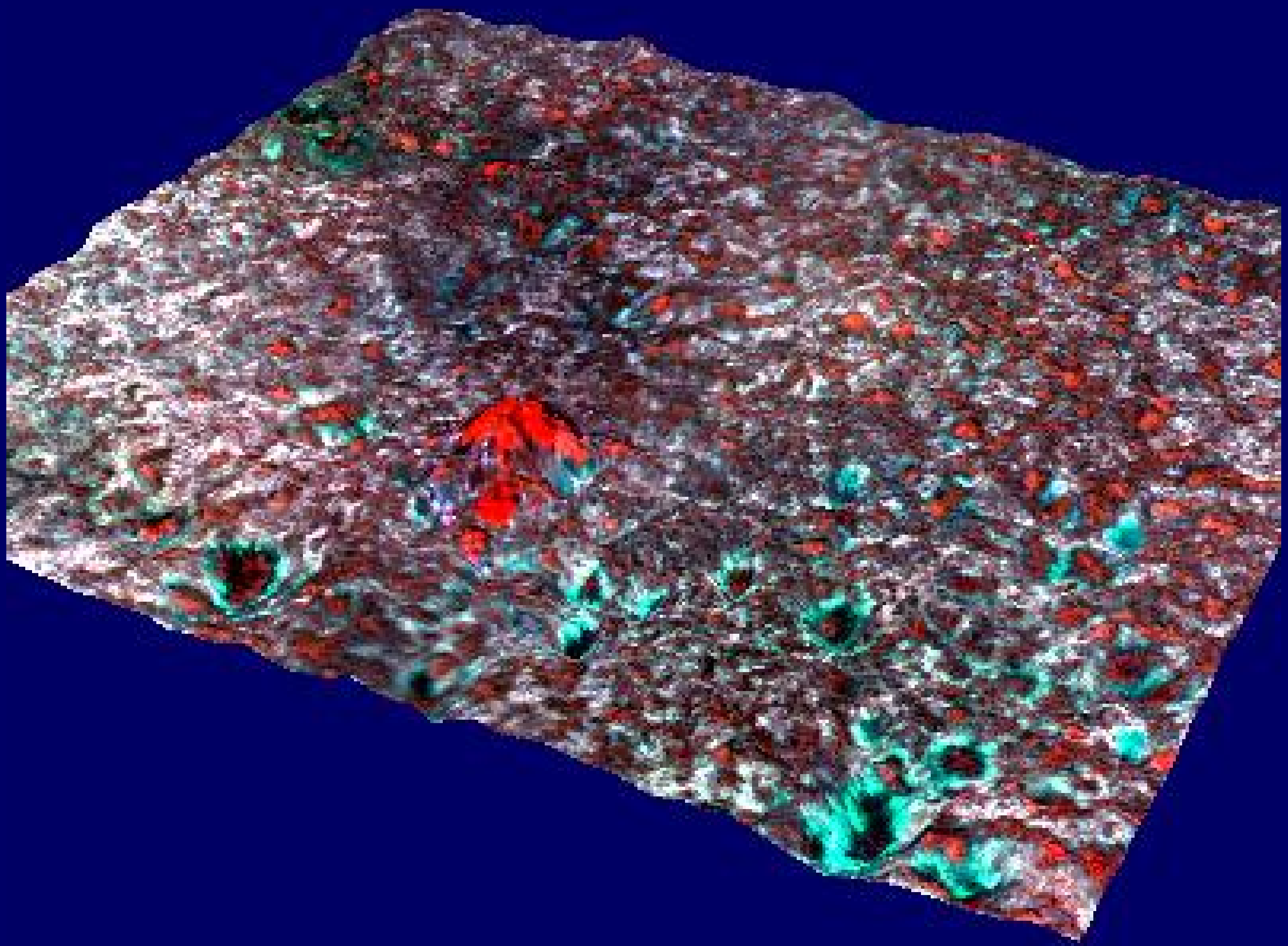
Why not use LIDAR?



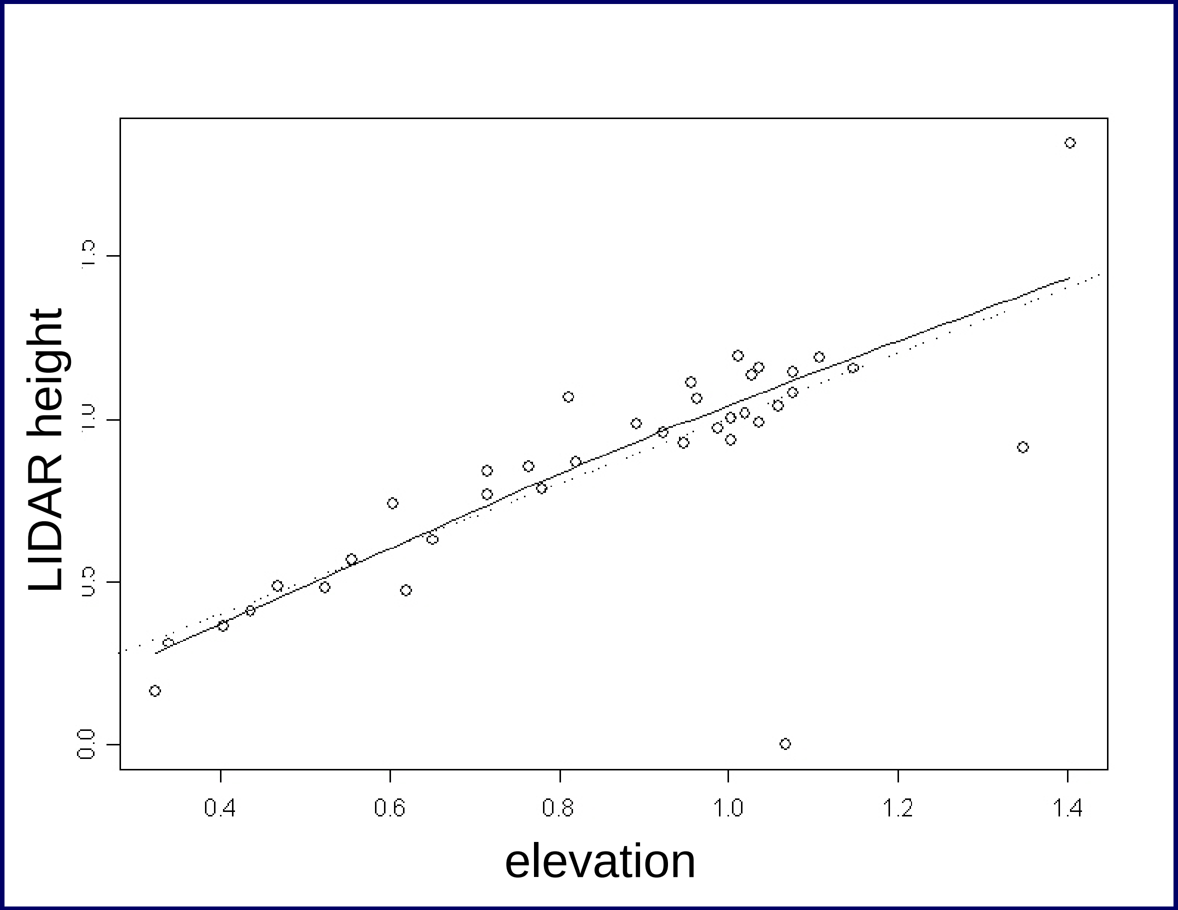
Vegetation

Water

Periphyton

Peat substrate

Why not use LIDAR?



Even with best case conditions (great LIDAR data and DRY ground)…

LIDAR RMSE exceeds the 15cm specification.

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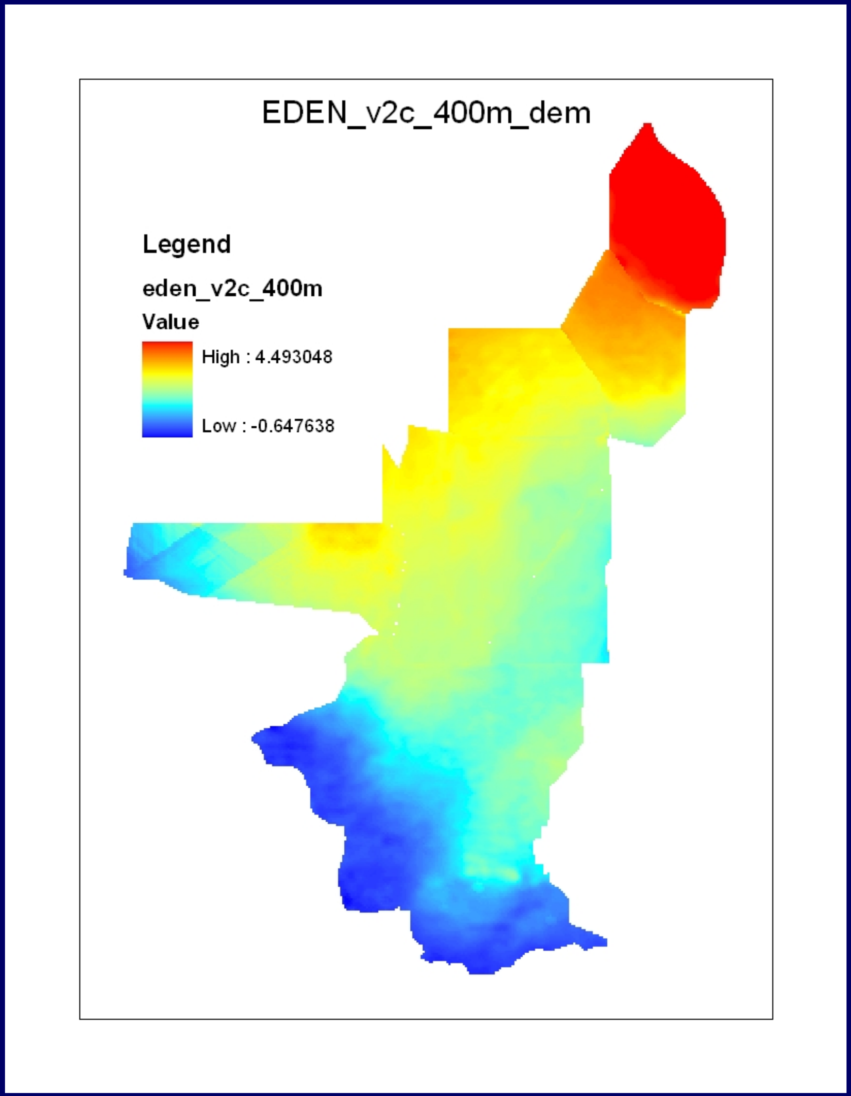
Airborne Height Finder

Initial EDEN DEM development



43,000+ AHF data points

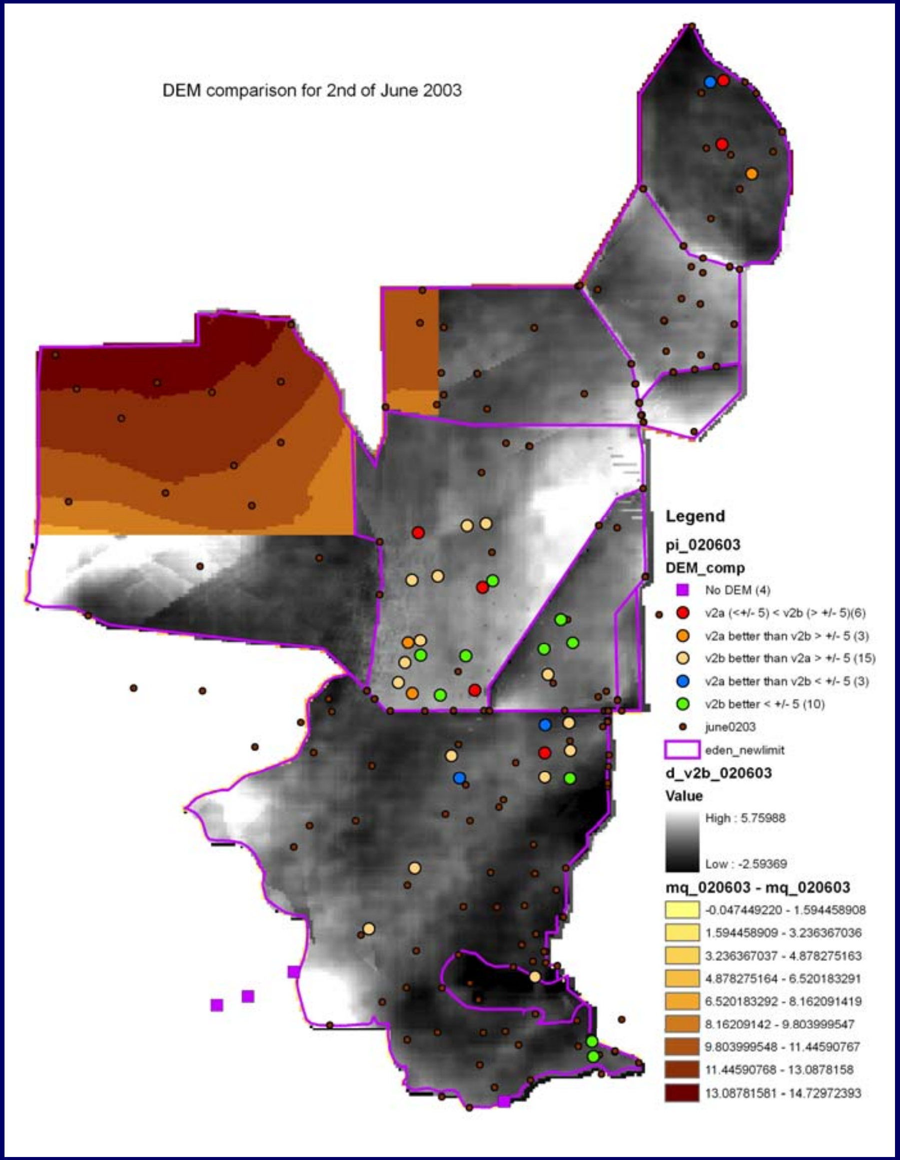
12,000+ Airboat data points

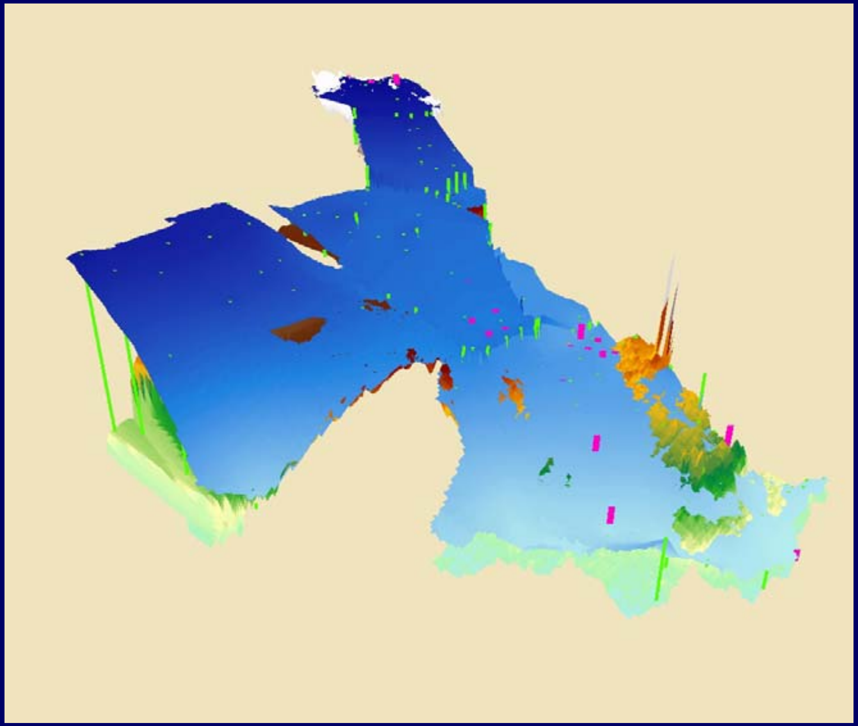
Ordinary kriging by subarea

Gaussian model

RMSE 0.08 – 0.13m

EDEN beta testing underway…





Modeled depth 06/03/02

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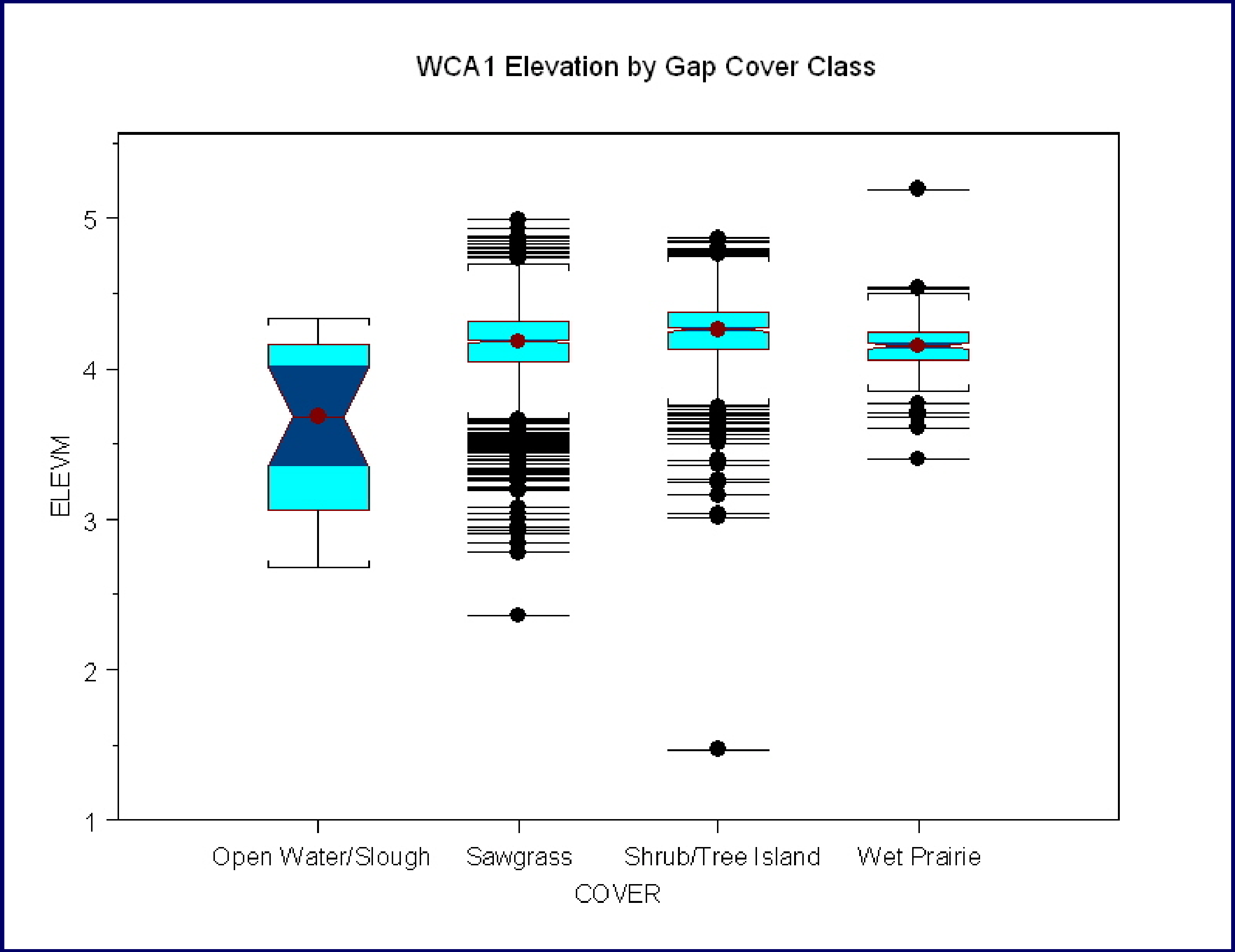
Current DEM refinement based on vegetation/topography relationships



PI-measured water depth by land cover type

AHF-measured ground elevation by land cover type

EDEN study implications

- Vegetation/topography relationships persist, but uncovering all of them will require judicious regionalization (via remote sensing…).

- Daily, spatially distributed depth estimates will aid biological sampling, habitat modeling, and facilitate remote sensing technology exploitation (e.g., RADAR).

Presentation Conclusions

- 3 Everglades case studies demonstrate a variety of Eastern Region USGS remote sensing research interests and capabilities.
- Remote sensing and geographic analyses are increasing understanding of Everglades land surface dynamics, vegetation processes, and vegetation/topography relationships.
- This understanding contributes to Everglades restoration planning and monitoring.

South Florida Information Access (SOFIA)
website: http://sofia.usgs.gov

Thank you!